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FEB 1 7 2004
PATENT & TRADEMARK OFFICE

AF/2815

PATENT
39943/PAN/C715

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of:	Choquette et al.	Group No.:	2815
Serial No.:	09/ 871,492	Examiner:	Warren, M.
Filed:	May 31, 2001		
For:	Long Wavelength Vertical Cavity Laser		

APPELLANT'S REPLY BRIEF (37 C.F.R. 1.193(b))

FEB 2 0 2004

Mail Stop Appeal Brief - Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

This Reply Brief is in response to the Examiner's Answer filed in this case on January 27, 2004.

This Reply Brief is transmitted in triplicate.

Respectfully submitted,

John P. Hohimer 2/11/04

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CERTIFICATE OF MAILING

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being deposited on the date shown below with the United States Postal Service in an envelope addressed to the Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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Reply to Examiner's Answer

(1) The Office on page 6 of the Examiner's Answer provides an additional motivation in support of the § 103 rejection of exemplary Claim 1 which has not been presented previously. The Office states in essence that the VCSEL of Lebby et al has deficiencies which would be cured by the addition of a tunnel junction as taught by Brillouet et al. Specifically, the Office cites Brillouet et al as disclosing a tunnel junction adjacent to a top mirror which "improves the reflectance and low electrical resistance of that mirror"; that the tunnel junction "allows that pumping current to be conducted from the top mirror to the active region without a potential drop (col. 5, lines 6-13)"; and that "the addition of a tunnel junction has been taught by Brillouet to improve the reflectance of the top mirror." Appellants respectfully traverse each of these statements by the Office as being unsupported by Brillouet et al.

Appellants respectfully submit that the Office has not shown anywhere in Lebby et al there is any teaching or suggestion that a deficiency exists that must be cured. The VCSEL of Lebby et al is fully functional, as is, so that one skilled in the art would not be motivated to change it by including a tunnel junction as taught by Brillouet et al and by reversing the polarity of the top mirror from p-type to n-type as required by Brillouet et al.

Appellants further respectfully submit that Brillouet et al does not disclose that the presence of a tunnel junction improves either the reflectance of an adjacent mirror or the electrical resistance of that mirror contrary to the statements by the Office in the Examiners' Answer. Brillouet et al disclose that:

> It is known that doping concentrations that are high enough to constitute a tunnel junction give rise to strong light absorption in the doped material. In the context of the present invention, it has nevertheless been found that in spite of the large power drop which could result from light passing through a semiconductor material doped in this way, it is possible without spoiling current conduction to limit the thicknesses of the tunnel junction layers to values that are small enough to ensure that the overall absorption of light is itself small enough to avoid significantly disturbing the establishment of appropriate light oscillation in the optical cavity of the laser. (col. 5, lines 14-25)

The above statement provides evidence to show that the presence of a tunnel junction, contrary to the statements above by the Office, produces an additional light absorption loss which will reduce the reflectivity of the mirrors to some extent. Additionally, this citation shows that the presence of the tunnel junction can further increase the electrical resistance (which is related to the current

conduction) as the thickness of the tunnel junction is reduced to reduce the strong light absorption. The teaching in the above citation from Brillouet et al shows that the inclusion of a tunnel junction does not improve the mirror reflectance and lower the electrical resistance of the mirror as suggested by the Office, but to some extent can have the opposite effect. Brillouet et al further disclose above that a trade-off must be made to minimize the degradation of the mirror reflectivity due to the strong light absorption in the tunnel junction by limiting the thickness of the tunnel junction, and that this, in turn, can deleteriously affect the current conduction and resistivity if one is not very careful.

Brillouet et al further states that doping concentrations within the tunnel junction "are high enough for a tunnel effect to enable this junction to conduct the pumping current from the top mirror to the second injection layer without giving rise to a **troublesome** potential drop." (col. 5, lines 6-10, emphasis added). Appellants respectfully submit that the statement "without giving rise to a troublesome potential drop" would be viewed by one skilled in the art as indicating the presence of some potential drop, however small. Further evidence for the existence of a potential drop in Brillouet et al can be found in col. 8, lines 37-51:

> Insofar as such variation in energy level is large and sudden, ignoring the passage between an injection layer and the active layer, it gives rise to a potential difference that constitutes an obstacle to the passage of the laser pumping current. Another obstacle to the passage of this pumping current could also be constituted by the fact that a tunnel junction layer with very high doping concentration is simultaneously very fine and in contact with a layer having low doping concentration. Under such circumstances, the low concentration layer could capture charge carriers from the tunnel junction layer and thus oppose the tunnel effect which enables the current to pass. The presence of an obstacle as indicated above would cause the electrical power consumed by the laser to be increased, thereby also increasing the thermal power that needs to be evacuated.

This citation shows there are obstacles (i.e. a potential drop) to current flow through the tunnel junction in Brillouet et al. Brillouet et al further show that these potential drops can be limited by providing graded interfaces between the tunnel junction and adjacent layers (see col. 8, lines 51-67). Appellants urge that the statement in the Examiners' Answer that Brillouet "allows that pumping current to be conducted from the top mirror to the active region without a potential drop" is incorrect in view of the above citations which clearly show the existence of a potential drop. Thus, a VCSEL formed by combining Brillouet et al with Lebby et al would have an additional potential drop due to the tunnel junction which was not present in the device of Lebby et al without the tunnel junction.

Appellants respectfully submit that the additional motivation set forth by the Office in the Examiner's Answer does not correctly reflect the teachings of Brillouet as cited above. Appellants further urge that one skilled in the art would not be motivated to combine Brillouet et al with Lebby et al to form a VCSEL having an improved reflectance and lower electrical resistance since there is no teaching in Brillouet et al to show that this would occur, but rather the teaching in Brillouet et al is in the opposite direction for some degradation, however slight, in both reflectance and electrical resistance. Furthermore, there is nothing in Lebby et al that teaches or suggests any deficiency that must be cured by altering the structure of the VCSEL of Lebby et al. Therefore, Appellants respectfully submit that the Office has not shown the requisite motivation needed to form a valid *prima facie* case of obviousness for the rejection of exemplary Claim 1.

(2) The Office on page 7 of the Examiners' Answer cites Brillouet et al for disclosing mirrors formed of gallium arsenide (GaAs) and gallium-aluminum arsenide (GaAlAs) "having a crystal lattice match that does not match that of the indium phosphide chip." (col. 6, lines 1-7). The Office further states on page 7: "In essence, Brillouet does not require InP/InGaAsP mirrors as stated by the appellant and further states that the laser still operates if there is a lattice mismatch between the mirrors and the active region."

The statements in Appellants' Brief about Lebby et al teaching away from InP/InGaAsP mirrors were directed only to a bottom mirror, and not to the top mirror. Brillouet does not teach or suggest any semiconductors other than InP/InGaAsP for the bottom mirror which is formed on an InP substrate (see col. 4, lines 19-26). The Office mistakenly cites col. 6, lines 1-7 in Brillouet as referring to both DBR mirrors. However, col. 6, lines 1-7 refers only to the top mirror, and not to the bottom mirror which remains formed from InP/InGaAsP. This can be clearly seen in the citation below from col. 6, lines 1-7:

> In the laser described above, the N-type **top mirror** is constituted by materials having the same crystal lattice as the indium phosphide chip. Nevertheless, it is possible to make **the mirror** by alternating layers of gallium arsenide GaAs and of gallium-aluminum arsenide GaAlAs, said layers being of N type, but having a crystal lattice that does not match that of the indium phosphide chip. (emphasis added)

Thus, forming a VCSEL according to Brillouet et al would still require a bottom InP/InGaAsP mirror regardless of what the top mirror is made of; and this requirement for a bottom InP/ InGaAsP mirror in Brillouet et al is contrary to Lebby et al who teach against the use of a bottom

mirror formed from InP/InGaAsP because "In this system, however, it is practically impossible to achieve decent DBR based mirrors because of the insignificant difference in the refractive indices in this material system." (Lebby et al, col. 1, lines 43-49). The contrary teachings of these two references with regard to the bottom DBR mirror provide evidence for the *prima facie* unobviousness of this combination set forth by the Office.

The teaching in Brillouet et al for a lattice mismatched top mirror in col. 6, lines 1-7 is also contrary to Lebby et al who require that both the top and bottom mirrors be lattice matched. Lebby et al explicitly state this for the top mirror (i.e. the second stack) in col. 4, lines 53-37:

> Second stack 26 of distributed Bragg reflectors is grown by epitaxially depositing pairs of layers on second oxide layer 27 (discussed previously). In order to crystal lattice match stack 26 to active structure 23, a suitable semiconductor material system must be deposited.

and for the bottom mirror (i.e. the first stack) in col. 3, lines 34-37:

> First stack 14 of distributed Bragg reflectors is grown by epitaxially depositing pairs of layers on substrate 12. In order to crystal lattice match stack 14 to substrate 12 a suitable semiconductor material system must be deposited.

Appellants respectfully submit that the contrary teachings in these two references provides further evidence for the *prima facie* unobviousness of Appellants' claimed invention in view of this combination set forth by the Office.